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13. ABSTRACT *(Maximum 200 words)*

The author has studied the qualitative behaviour of nonlinear waves for hyperbolic conservation laws with or without the effects of dissipations, discretization, or nonlinear resonance. The fundamental problem of well-posedness theory for hyperbolic conservation laws is being resolved. It is shown that no physical law, beyond the second law of thermodynamics, is needed. The shock waves for finite difference schemes are shown to have slow decaying tails due to the effect of small divisor. Physical degenerate dissipation matrix is shown to give rise to rich nonlinear wave phenomena. Nonlinear waves for non-strictly hyperbolic system are shown to behave sensitively as a functional of the dissipation matrix. The ideas of wave tracing and pointwise estimates introduced by the author play the central role in the analysis of these problems.

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NONLINEAR WAVES IN MECHANICS AND GAS DYNAMICS

FINAL PROGRESS REPORT

TAI-PING LIU

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Final Progress Report for period 4/1/94 to 3/31/97

Title: Nonlinear waves in mechanics and gas dynamics
Author: Tai-Ping Liu
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The author has done the following research on qualitative understanding of nonlinear partial differential equations arising in continuum physics.

With Kevin Zumbrun, we have studied stability of shock waves for multiphase model. These waves are less compressible than the gas dynamics shocks which makes it necessary to trace their locations. [55,56]

[55] (with K. Zumbrun) Nonlinear stability of an undercompressive shock for complex Burgers equation, Comm. Math. Physics, 168(1995), 163-186.

[56] Gas flows with damping and vacuum, Japan J. Indus. and Appl. Math. 13(1996), 25-32.

With Yanni Zeng we studied the time-asymptotic behavior of conservation laws with physical viscosity matrix. Such a matrix is necessarily degenerate and one needs to study the dual parabolic-hyperbolic nature of the system. [58,61]

[58] (with Y. Zeng) Large time behavior of solutions of general quasilinear hyperbolic-parabolic systems of conservation laws, Memoirs, Amer. Math. Soc. No.599 (1997).

[61] (with Y. Zeng) Compressible Navier-Stokes equations with zero heat conductivity, (preprint).

The following paper on the stability of viscous shocks is the main paper where the author introduces the pointwise estimate approach [66].

[66] Pointwise convergence to shock waves for viscous conservation laws, Comm. Pure Appl. Math. (to appear).

The approach has proven effective in studying various other types of nonlinear waves. In the following paper with Zhouping Xin, it is applied to the study of viscous contact discontinuities [62].

[62] (with Z. Xin) Pointwise decay to contact continuities for viscous conservation laws, Asian J. Math. (to appear).

Overcompressive and undercompressive shocks depend sensitively on the value of dissipation parameters. This issue is studied in the following paper [65].

[65] Zero dissipation and stability of shock waves, (preprint).

With Shih-Hsien Yu we have studied the traveling waves for the finite difference schemes of shock computations. We show that, even for dissipative schemes such as Lax-Friedrichs and Godunov schemes, the tail behavior depends on its speed sensitively. In the following paper we study waves whose speed relative to the C-F-L number is Diophantine number [63,69].

[63] (with S.-H. Yu) Continuum shock profiles for discrete conservation laws, I. Construction.(preprint).

[69] (with T. Ruggeri) Entropy production and admissibility of shocks, (preprint).

REPORT DOCUMENTATION PAGE (SF298)
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The combined effect of physical boundary and the dissipation on the propagation of shocks is studied in [59,64].

[59] (with S. Yu) Propagation of Burgers stationary shocks under boundary effect, Archive Rational Mech. Anal., (to appear).

[64] (with K. Nishihara and A. Matsumura) Asymptotic behaviour for scalar viscous conservation law with boundary effect, J.D.E. 133 (1997), 296-320.

Tong Yang and the author are working on a major project, the well-posedness theory for hyperbolic conservation laws. We have already obtained a preliminary result when one of the solutions is a constant solution [68].

[68] (with S.-H. Yu) Continuum shock profiles for discrete conservation laws, II. Stability. (preprint).